



**Problem 1** – Astronomers have classified the 160 largest galaxies in the Virgo Cluster according to whether they are spiral-shaped (S and SB), elliptical-shaped (E) or irregular (I). The bar graph to the left shows the number in each category. From the survey, 81 were classed as S, 19 were classed as E, 56 were classed as SB and 3 were classed as I. About what fraction of galaxies in the cluster are spirals?

**Problem 2** – Gamma-ray bursts happen about once each day. The bar graph to the right sorts the 1132 bursts detected between 1991-1996 into two categories. There are 320 FBs and 812 SBs indicated in the bar graph. Slow Bursts (SB) are longer than 2 seconds, and may be produced by supernovas in distant galaxies. Fast Bursts (FB) lasting less than 2 seconds may be produced by colliding neutron stars inside our own Milky Way galaxy. What would you predict for 2009 as the number of bursts that might probably come from outside the Milky Way?

## Answer Key

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Answer: There are two categories of spiral galaxies indicated by S and SB for a total of  $56 + 81 = 137$  galaxies. Since there are 160 total galaxies, the fraction of spirals is  $137/160 = 0.86$ , or equivalently 86%.

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Answer: There are 320 FBs and 812 SBs indicated in the bar graph. The total number is 1132 over the course of 1996-1991 = 5 years, so that there are  $1132/5 = 226$  each year. The ones that probably come from outside the Milky Way are the SBs for which the fraction that were seen between 1991-1996 is  $812/1132 = 0.72$ . For a single year, 2009, we would predict about 226 bursts, of which  $226 \times 0.72 = 163$  would be SBs.